



Tin Zinc Plating for Grounding Applications

1 Scope

This specification covers the requirements for tin-zinc electroplate on steel substrates, with provisions for supplementary treatment. This finish is intended for corrosion resistance and electrical grounding purposes.

1.1 Material Description. The material approved to this specification is a tin-zinc electroplate layer with passivation layer, plus a subsequent topcoat providing additional corrosion protection and consistent coefficient of friction.

1.2 Symbols. Not applicable.

1.3 Applicability. This finish is suitable for fasteners and other small parts designated for electrical grounding purposes. The applicable temperatures are from -50 °C to 150 °C, above which, the corrosion protection performance will degrade. Consult Materials Engineering for higher temperature applications.

Note: This coating shall not be used for applications exceeding 195 °C during manufacture or in service.

1.4 Remarks.

1.4.1 The global availability of this finish is low. GMW4700 ZnNi Type B Code G is a good alternative for grounding and corrosion protection. Note: GMW4700 is not a drop-in replacement for GMW3200. Consult Materials Engineering for design and validation requirements.

1.4.2 Use of this coating on threaded surfaces and/or bearing surfaces of joints could affect the torque-tension relationship. It is recommended that a torque-tension study of the fastener joint be performed before releasing this finish on new application.

1.4.3 This coating contains a protective topcoat for friction control and additional corrosion protection. For threaded fasteners, the assembly (tightening) process overcomes this topcoat and result in good electrical conductivity on approved finish materials. However, for non-threaded parts, the topcoat may decrease electrical conductivity. It is recommended that a study of the electrical conductivity of the part/joint be performed before releasing this finish on new applications. For special applications where the topcoat is undesirable, the finish may be specified as "NO TOPCOAT".

1.4.4 This coating system must be free of hexavalent chromium, with no hexavalent chromium in final product per the requirements of GMW3059. GMW3034 shall be used as a referee test.

1.4.5 Due to risk of hydrogen embrittlement, electroplating parts with maximum hardness higher than HRc 48 is not recommended.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

ASTM F1470	ISO 9227	SAE/USCAR-5	SAE/USCAR-11
ISO 1463	ISO 16047	SAE/USCAR-7	

2.2 GM Standards/Specifications.

GMW3034	GMW4700	GMW14872
GMW3059	GMW14270	

3 Requirements

The parts finished to this specification shall meet the following technical requirements and demonstrated by the test methods described. The appropriate tests for different situations: New chemical approval, new applicator approval, Production Part Approval Process (PPAP), and regular process control testing, are described in Appendix A, Table A1.

3.1 Mechanical Requirements. The coating shall have good adhesion to the base material. There shall be no blistering or flaking after heat treatment as detailed in paragraph 3.7.

Note: This test is for initial approval of the finish material and referee purposes only.

3.2 Appearance. The appearance of this finish is to be silver-gray in color, with a uniform appearance. While exact color and gloss are typically not specified, parts within the same delivered lot shall have the same appearance. The finished parts shall be clean, non-tacky and dry to touch. When finished parts are laid on consumer tissue paper for more than 1 minute, it must not stick to or stain the tissue paper.

3.3 Alloy Content. The alloy content must be consistent throughout the entire electrodeposited layer. The alloy content range shall be 65% to 80% weight tin (Sn), with the reminder zinc (Zn). The referee method for determining the alloy content is by X-ray Fluorescence (XRF) or spot-mode Energy Dispersive X-ray Spectroscopy (EDS).

3.4 Plating Thickness.

3.4.1 The plating layer thickness is defined as the metallic zinc alloy layer measured after all specified supplemental treatments are completed. However, the measurement of plating thickness does not include any subsequent topcoat. The plating layer thickness on significant surfaces shall be a minimum of 8 μm .

3.4.2 The plating thickness on bolts and screws shall be measured on the head, on a surface as close to flat as possible, and away from corners and edges. For referee purposes in cases when it is not possible to accurately measure the plating thickness on the head (e.g., the plating is mechanically damaged or it was already exposed to a corrosion test), the point of the bolt/screw or tip of an unexposed thread may be measured and compared to a reference part plated in the same process. On nuts, the plating thickness shall be measured on the spanner flats.

3.4.3 For parts other than threaded fasteners, the plating thickness requirement applies to significant surfaces as specified on engineering drawings. If the significant surfaces are not defined, all surfaces are considered significant.

3.4.4 For threaded fasteners, the maximum total thickness of the plating and topcoat is limited by the basic thread size (tolerance h or H). After plating and topcoat, parts must gauge with appropriate basic size GO thread gauge. Threads may be produced undersize/oversize to accommodate the coating provided that the finished product meets all specified mechanical properties. Where mechanical properties are not specified, undersizing/oversizing is subject to approval by the responsible Fastening Engineer and all undersizing/oversizing shall be within permissible limits as agreed upon.

3.4.5 For parts other than threaded fasteners, there is no limit on maximum total coating thickness as long as the finish meets all other requirements and does not negatively affect the function of the part.

3.4.6 For referee purposes, the plating thickness shall be determined by microscopic examination of cross sections taken perpendicular to significant surfaces per ISO 1463. For regular production lot certification, a calibrated XRF can be used for plating thickness measurement. The measurement shall be taken after the entire finishing process is complete. The measurement method shall have good accuracy and be robust to the finish material, substrate material, part size, and geometry. In case of dispute, the supplier must be able to demonstrate a maximum deviation of 10% between its test method and the cross-sectioning measurement per ISO 1463 when measuring the same area of the same part.

Note: Plating layer thickness measurement shall be reported for each production lot.

3.5 Corrosion Resistance (NSS).

3.5.1 Parts shall exhibit no white corrosion products on significant surfaces after Neutral Salt Spray (NSS) testing per ISO 9227 for 48 h.

Parts shall exhibit no red corrosion products on significant surfaces after NSS testing per ISO 9227 for 1000 h.

If "NO TOPCOAT" is specified, then the hours to red rust shall be 720 h and no NSS test requirement for white corrosion. Also, cyclic corrosion test per 3.5.7 do not apply.

Note: Due to the varying severity of corrosive conditions and applications in a vehicle, the hours to develop white or red corrosion shall not be construed as having any correlation to the actual service life of the part.

3.5.2 Corrosion Test. Test finished parts per ISO 9227 (NSS) with the following additional requirements:

- The sample holder inside the test cabinet/chamber shall be constructed of material resistant to the test environment, i.e., acrylic and Polyvinyl Chloride (PVC). Also, the sample holder material, i.e., metal and wood, shall not affect the corrosion test results.
- The orientation of the parts during test is slightly slanted to minimize accumulation of test solution on the finished surface. The placement and orientation of test parts shall be such that parts are not touching and that they are not shielding each other from the test environment.
- Test parts shall not drip on each other during the test.
- Parts to be tested shall be as close to as-shipped condition as possible. No special cleaning or treatments allowed.
- Parts may be aged at the ambient laboratory conditions $23\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ and relative humidity of $45\% \pm 10\%$ for at least 24 h before the exposure.

3.5.3 Significant surfaces for test evaluation of fasteners shall be all exposed surfaces of the fastener when installed, including, but not limited to, fastener heads, socket recess, SEMS washers, and external surfaces of nuts. Fastener threads and points are excluded unless otherwise specified on the drawing.

3.5.4 Significant surfaces on parts other than threaded fasteners shall be all surfaces. Deep recesses, such as blind holes and the interior of tubes, are excluded unless otherwise specified on the drawing.

3.5.5 Temperature Resistance. After heating the parts for 1 h at $150\text{ }^{\circ}\text{C}$ (part temperature) the corrosion resistance requirements specified in paragraph 3.5.1 shall be met. This test requirement is only for initial approval of the finish material.

3.5.6 Cathodic Protection. The cathodic protection capability of the plating shall be tested by NSS per ISO 9227 with a specimen that is scratched to the base metal, the scratch having a width of not more than 0.5 mm. After 96 h of NSS testing, there shall be no red corrosion products in the area of the scratch. This test is required only for the initial approval of the finish material.

3.5.7 Cyclic Corrosion. Plated parts shall be cyclic corrosion tested per GMW14872, EXT, All, 4sp, Method 1/2/3, Exposure C. After exposure, there shall be no more than 50% white corrosion products and no red corrosion products on significant surfaces as defined in 3.5.3. This test requirement is only for initial approval of the finish material.

3.6 Electrical Grounding. Plated parts shall be tested to the Electrical Ground Test Procedure for Finishes located in Appendix B for initial approval of the finish material. Resistance increase shall be $\leq 10\text{ m}\Omega$.

3.7 Hydrogen Embrittlement Relief. All electroplated parts with surface or core hardness greater than 320 HV (32 HRC) shall be processed per SAE/USCAR-5 and tested for de-embrittlement per SAE/USCAR-7, except bake temperature is to be $187\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$. The sample size for the SAE/USCAR-7 test shall be per ASTM F1470. The maximum material hardness in the drawing or relevant specification shall be used to determine if de-embrittlement baking is required. If a part is heavily cold worked or heat treated to high strength/hardness but is without a maximum hardness limit stated in the drawing or specification, the applicator shall obtain the hardness data from the customer in order to determine if de-embrittlement baking is required.

When a part requires baking after plating, the supplementary treatment may be applied after the baking operation. The order of baking and supplementary treatment must be determined at the time of applicator approval and detailed in the applicator's process control plan and cannot be modified without additional testing and approval from GM.

3.8 Torque Tension and Friction Coefficient.

3.8.1 Plating chemical systems shall have a lubricant integrated into the topcoat and meet the electrical conductivity requirements on threaded fasteners per 3.6.

3.8.2 Torque Tension. Metric threaded fasteners M6 and larger shall be subject to torque-tension testing monitoring through the use of surrogate M10 x 1.5 test bolts. Ten surrogate bolts shall be processed with the production parts. A minimum of 10 bolts shall be tested per SAE/USCAR-11, except tightening speed shall be $30\text{ rpm} \pm 3\text{ rpm}$. The six (6) sigma torque range value must be within $48\text{ Nm} \pm 8\text{ Nm}$ measured at 28.3 kN tension. The bolt is GM part number 11516105. The nut part number is 11516090. The washer part number is 11502644. The test results shall be maintained in a file to be submitted when required.